

Assessment of TPHs and PAHs in the Marine Sediment Relating to Oil and Gas Extraction Activity on the western coastline of Qatar

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Abstract

Total Petroleum Hydrocarbons (TPHs) and Polycyclic Aromatic Hydrocarbons (PAHs) are priority pollutants which are known to be associated with petroleum products. They are released into the marine environment via accidental spillage, exploration and transportation. The present study aims to assess the impact of petroleum and gas extraction activities on the pollution of coastal marine sediment of the western coastline of Qatar. Sixty-six surface sediment samples were collected along the western coastal area. The concentration of organic hydrocarbons (TPHs and PAHs) were determined using GC-FID and GC-MS, respectively. Sediment characteristics including pH, temperature, TOC and particle size were also measured. The results indicated low concentrations of TPH (<0.001-0.246 µg/g dry weight sediment) and PAHs (<0.001-0.044 µg/g dry weight sediment). The concentrations for both organic pollutants were lower compared to the previous studies done within Qatar and in the Arabian Gulf and also indicated below the available permissible limit set by the Ministry of Municipality and Environment of Qatar and other Sediment Quality Guidelines (SQGs) used worldwide (NOAA).

Aims and Objectives

To assess the impact of petroleum and gas extraction activities on the pollution of coastal marine sediment of the western coastline of Qatar. The following objectives were followed:

- Surface marine sediments were collected from the western coastline of Qatar where the onshore oil and gas extraction stations exist.
- Concentrations of the organic hydrocarbons in the marine sediment were determined.
- Sediment samples data obtained were compared to the available permissible limit set by the Ministry of Municipality and Environment of Qatar and other Sediment Quality Guidelines (SQGs) used worldwide.

Study Area and Sampling

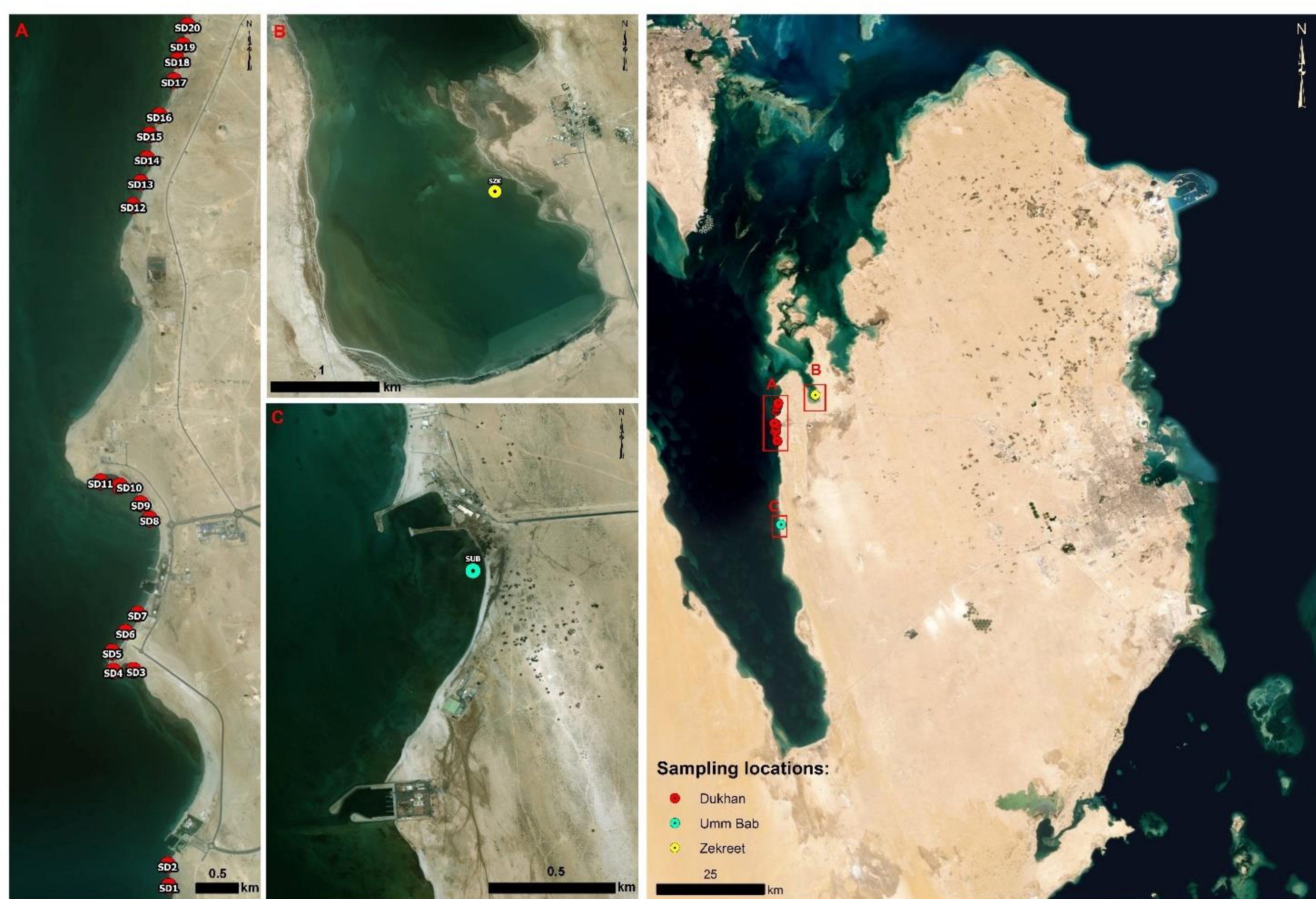


Figure 1. Map of Qatar showing the sediment sampling stations at three locations: Dukhan, Zekreet and Umm Bab. Base map: WorldView-2 satellite data acquired in November 2011 by DigitalGlobe, Inc (Esri).

The selected study area extends along the coastal area of Dukhan (main site) with two reference sites located approximately 29 km far north (Zekreet) and 24 km far south (Umm Bab) the main study site on the western coast of Qatar (Figure 1). Dukhan area is the largest onshore oil and gas field in Qatar producing crude oil, condensate gas, associated and non-associated gas that extends approximately 80 km by 8 km (QP, 2017). Major exploration activities and extraction stations are developed near the coastline.

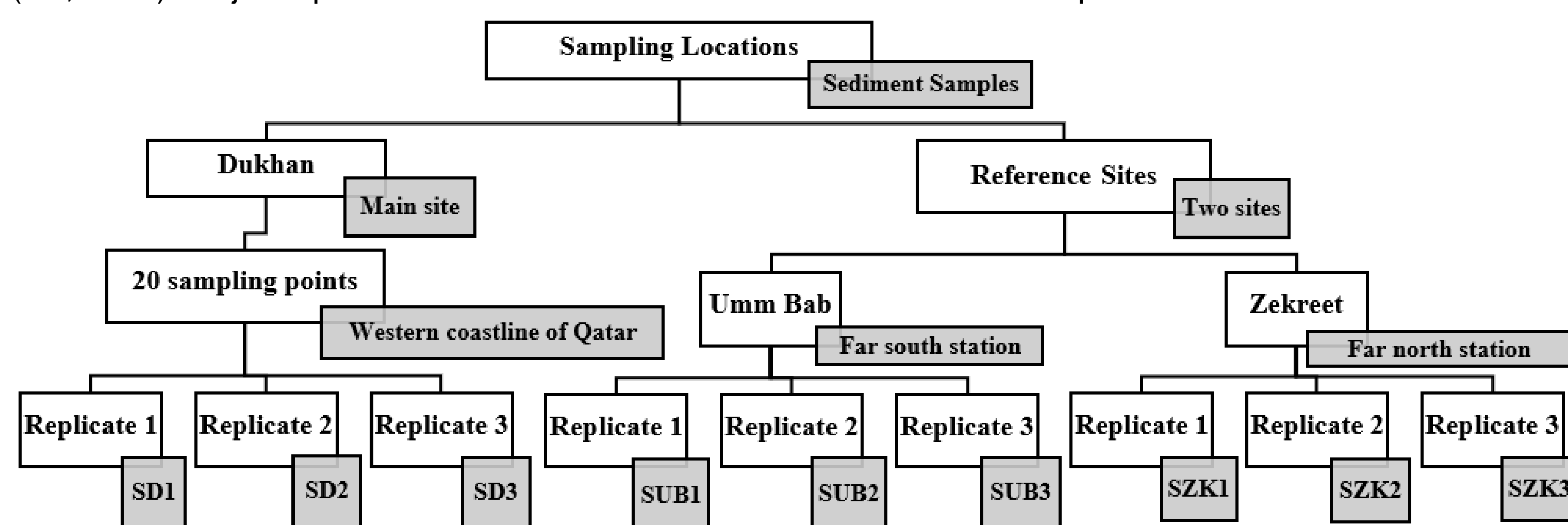


Figure 2. Sediment sampling procedure flow diagram.

Multiple surface coastal marine sediment samples (5 – 10 cm) were collected and homogenised into one sample from 20 sampling stations at Dukhan area (about 10 km length along the coastline) where several petroleum extraction stations occur. The distance from one sampling station and the other was approximately 500 m and 150 m far from the coast during the low tide. Also, one far north station at Zekreet and one far south station at Umm-Bab were sampled at a distance from the onshore operations. Three replicates (collection of three random samples from the same station) were collected from each station ending with total of 66 sediment samples. At each sampling station, data on sediment temperature and pH were measured in situ using a portable pH meter probe. A flow diagram summarizing the sampling procedure is shown below in (Figure 2).

Methodology

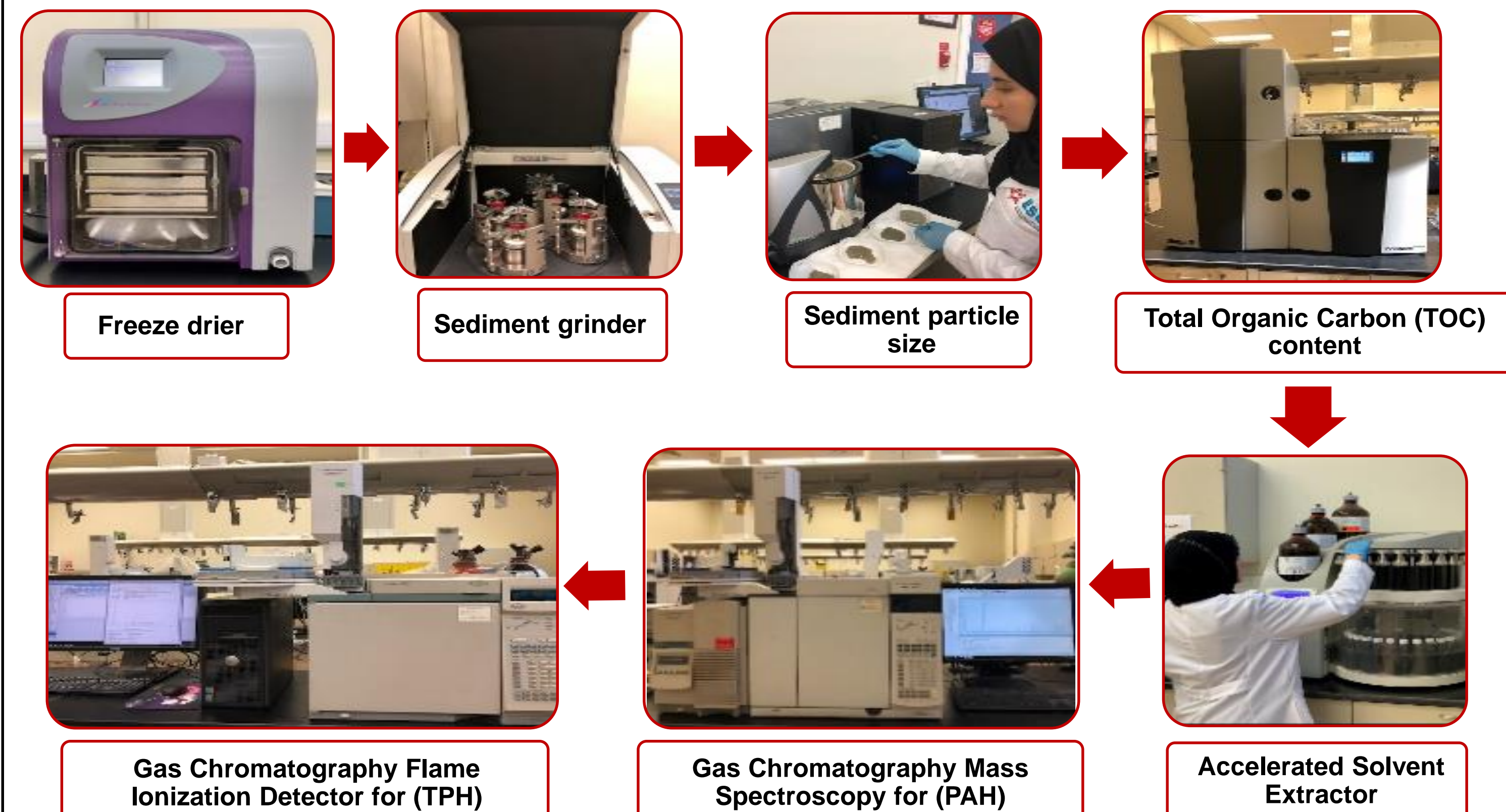


Figure 3. Flow chart of the preparation and analysis of sediment samples.

Results and Discussion

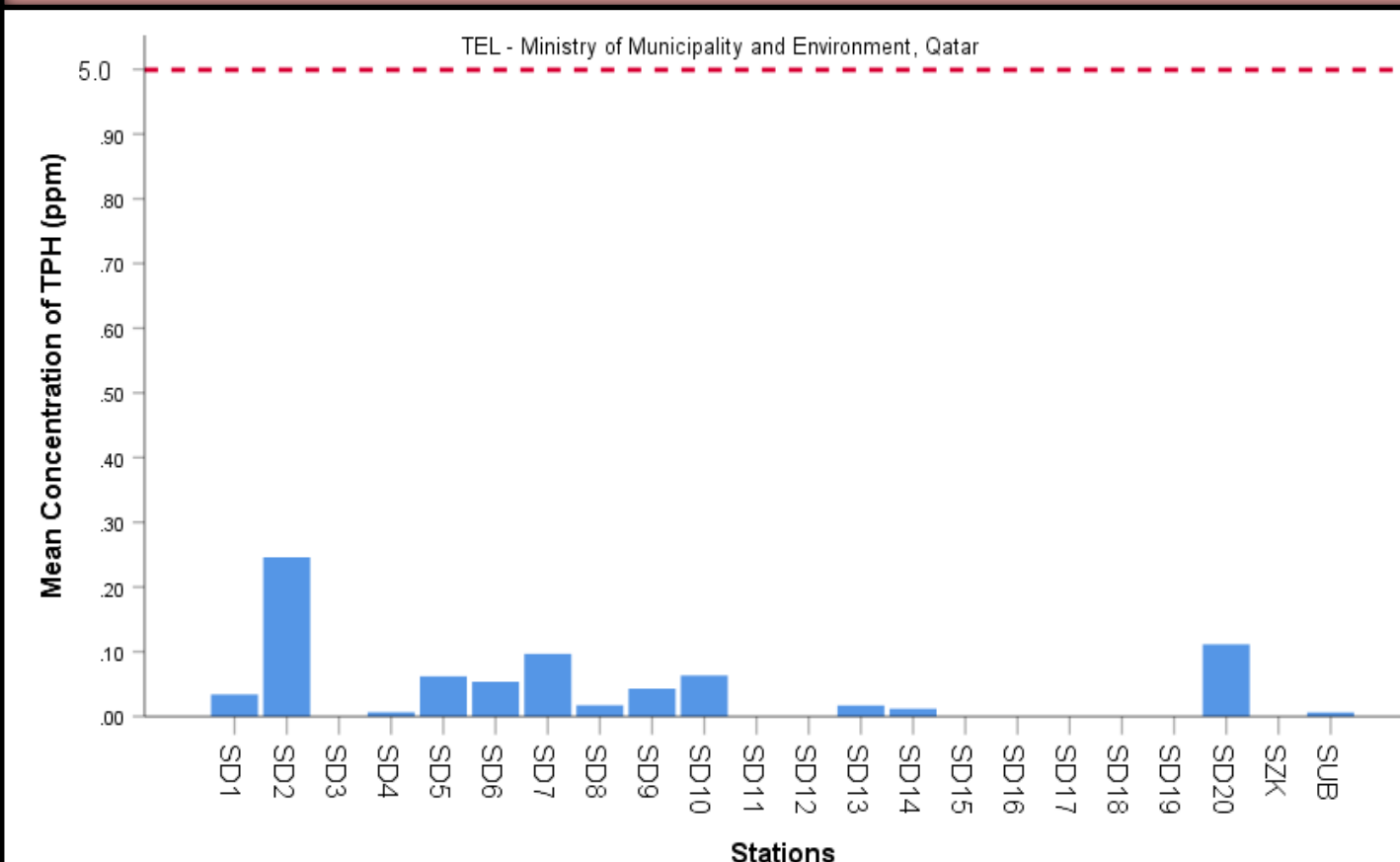


Figure 4. Mean total petroleum hydrocarbon concentrations in sediment samples of Qatar western coastline compared with local guidelines.

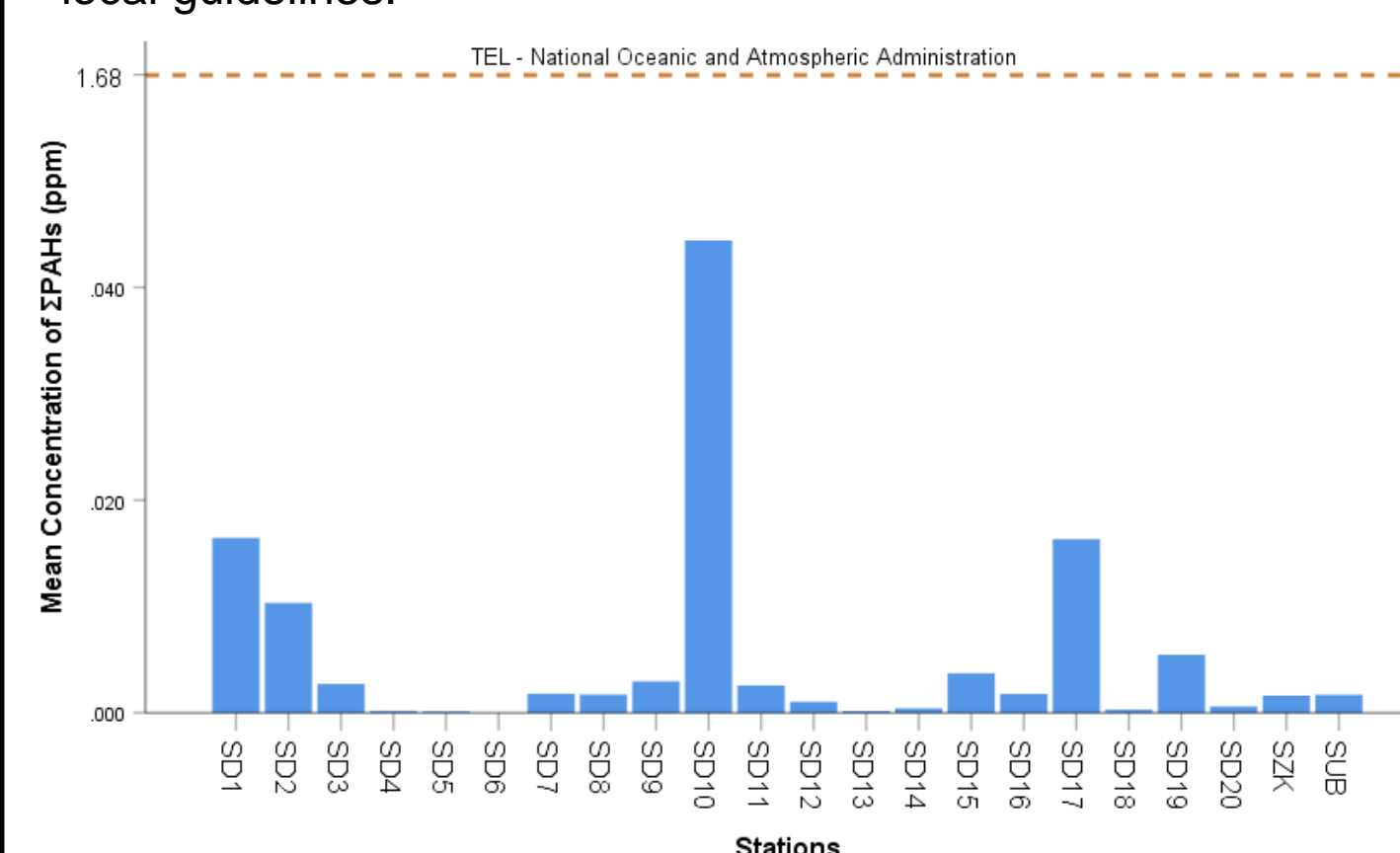


Figure 5. Mean total polycyclic aromatic hydrocarbons concentrations in sediment samples of Qatar western coastline compared with international guidelines.

- Many factors might contribute to the decrease of hydrocarbons concentrations such as the enforcement of regulations and the use of advanced technology that is more environmentally friendly during different phases of oil and gas extraction and production (Lang et al., 2007).
- Low concentrations of hydrocarbons observed in the present study is likely related to an increase in sediments temperature.
- This mainly contributes to volatilization, degradation and solubility of low molecular weight PAHs such as acenaphthylenes and naphthalenes by disturbing the partitioning of the PAHs between organic and aquatic phases (Cui et al., 2016).

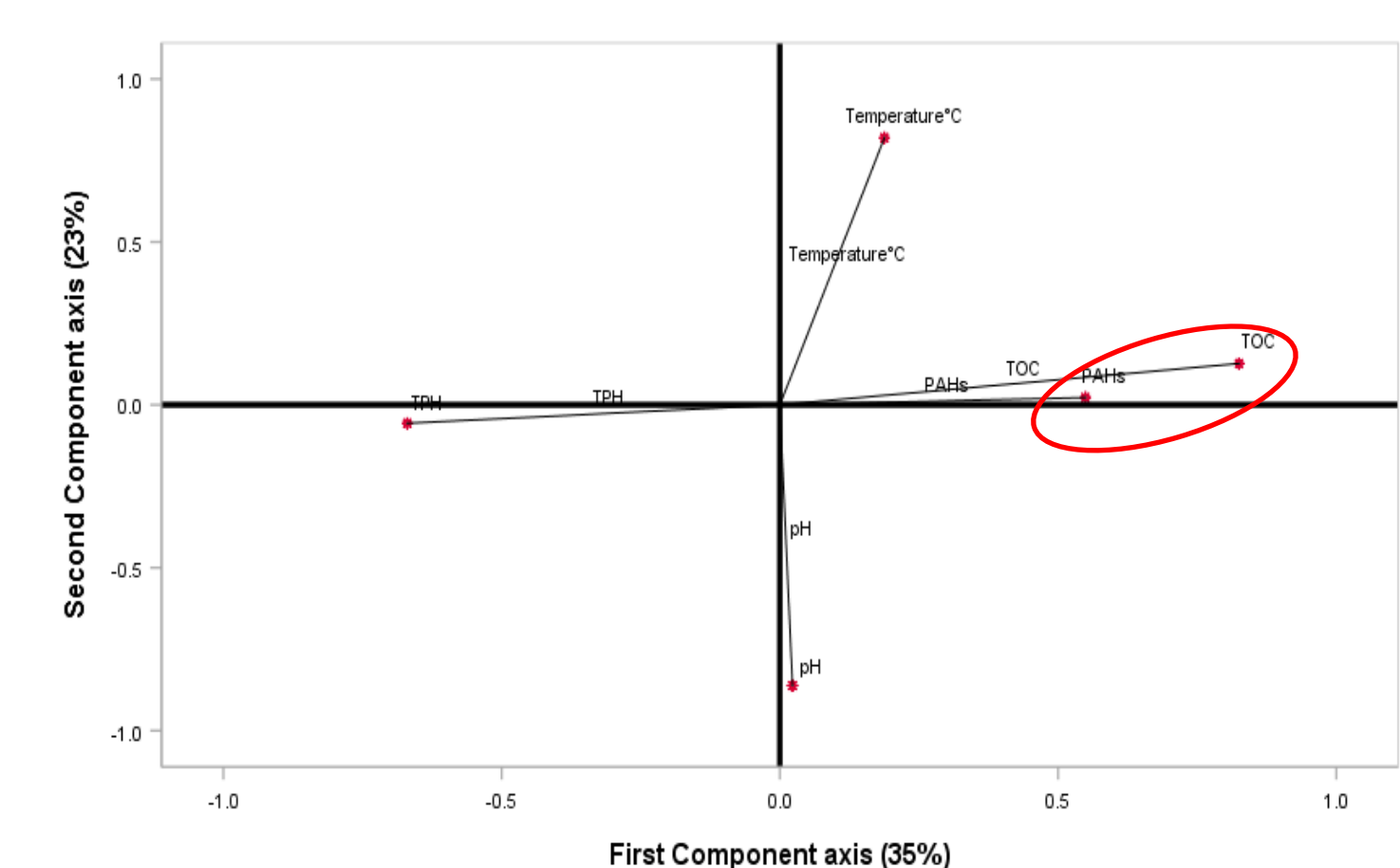


Figure 6. Principal Component Analysis (PCA) plot showing the correlation between the petroleum hydrocarbon pollutants and the physical parameters in sediment samples.

- The PAH concentrations in marine sediments of the western coastline of Qatar (present study) were significantly positive ($r = 0.276$ at 0.05 level) and high in the sediments with high TOC content due to the increase of the adsorption capacity of PAHs.
- The previous studies of Wang, Zhang and Chen, (2001) and Zhang et al. (2006) also showed a positive correlation between levels of TOC and PAHs in sediments of U.S. and in soils of Hong Kong respectively.

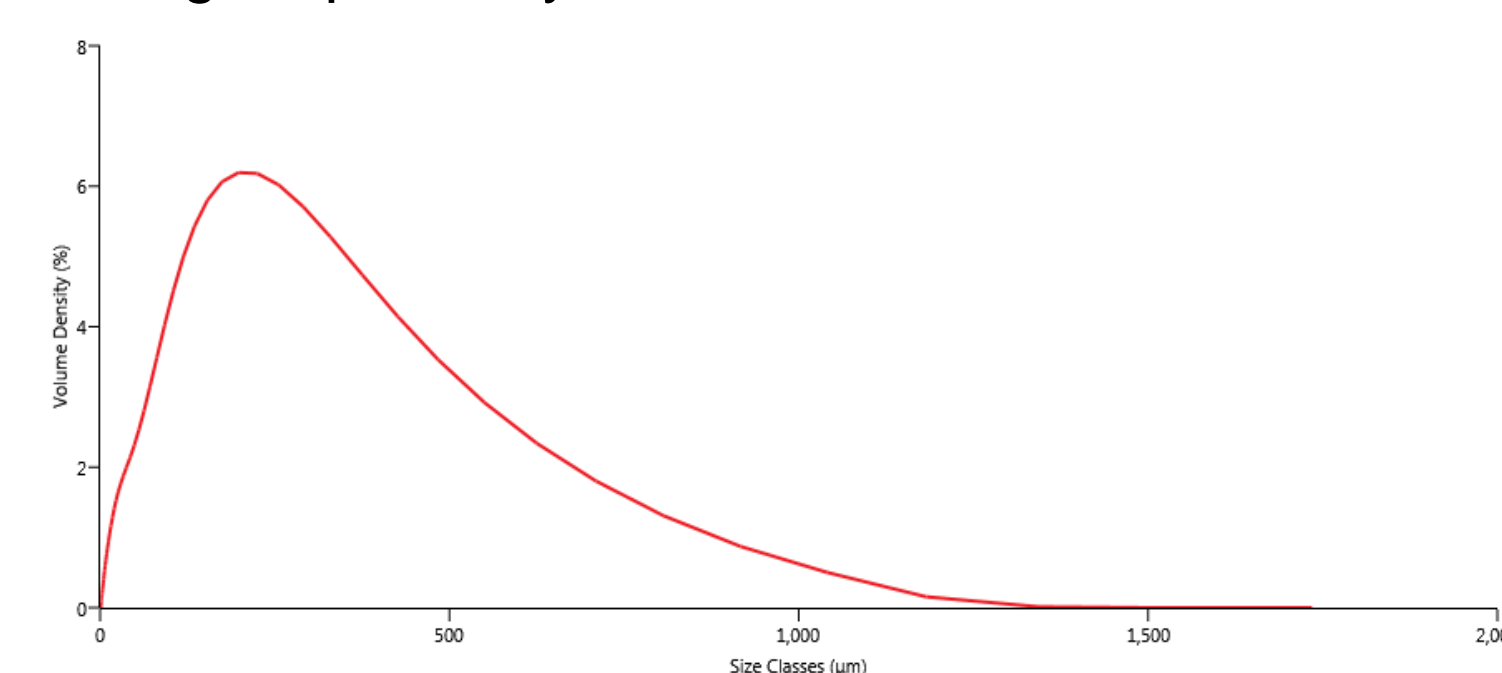


Figure 7. Sediment particle size distribution of station (SD1).

- The data indicated that station (SD1) have silty sand sediments (Figure 7) with relatively high TOC content and PAHs concentration, although this is not the case for all the other samples. Majority of the sediment samples were consisting of sandy particles ranging from 75 % to 100 % sand that have no impact on the PAHs concentration.

Conclusion

- According to the results obtained from the present study, it can be concluded that the petroleum and gas extraction activities along the western coastline of Qatar does not impact the marine sediments negatively.
- Further study in the future is essential to assess the impact associated with onshore anthropogenic activities on benthic marine biota.

References

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